Cruise report CEND09-11

Peltic11: a survey on sardine and other pelagic species in the western Channel and Celtic Sea

1. Outline of the survey

1.1 Staff

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Steve Warnes (2IC; Cefas)
Rob Bush (deputy 2IC and deckmaster; Cefas)
Fay Luxford (Oceanography; Cefas)
Mark Etherton (deckmaster and responsible for otolith reading)
Joana Silva (fish room coordinator and pelagic expert; Cefas)
Briz Parent (MSc student, France)
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Dave Brown (Acoustics and data-management; Cefas)
Ken May (Acoustics and technical advisor; Cefas)
Lisa Wynne (Irish Foreign Observer)
Cheryl Yarham (Marine mammal and bird observer; Marinelife)
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Rebecca Scott (Marine mammal and bird observer; Marinelife)

1.2 Duration

18th of May – 9th of June

1.3 Location

Western Channel and Celtic Sea plateau (embarking/disembarking in Lowestoft)

1.4 Objectives

1. To carry out a multidisciplinary pelagic survey of the Western Channel and Celtic Sea waters to estimate the biomass and gain insight into the population structure of sardine and other small pelagic fish species (anchovy, herring, sprat, horse mackerel, mackerel, boarfish, blue whiting).
    a. To carry out a fisheries acoustic survey using three operating frequencies (38, 120, 200kHz) during day light hours, to investigate:
        - distribution of sardine and other small pelagic species
        - abundance of sardine and other small pelagic species
        - distribution of the pelagic species in relation to their environment
    b. To trawl for small pelagics species, using an Engels 800 trawl, during daylight hours, in order to obtain information on:
        - Species- and size composition of acoustic marks

- Age-composition and distribution, from sardine and other small pelagic species
- Length weight and maturity information on pelagic species
- Genetic structure of sardine and anchovy. Finclips will be taken of subsets of sardine and anchovy and stored, to be genetically analysed.

2. To collect plankton samples using a 1m diameter ringnet (270µm mesh) and where possible a 0.5m diameter (80 µm mesh) at fixed stations along the acoustic transects at night and at a subset of trawl stations during the day. Where possible samples will be processed onboard:
   a. eggs and larvae of pelagic species will be identified and counted and combined with information from maturity to identify spawning areas.
   b. Zooplankton will be stored for further analysis back in the lab.
3. Water column sampling. At fixed stations (same as plankton samples) along the acoustic transect, a Rosette and ESM2 will be used at night to obtain a vertical profile of the water column. Water column profile and water samples will provide information on chlorophyll, oxygen salinity temperature, nutrient samples and the relevant QAQC samples for calibration of the equipment. Water samples will be collected and fixed on board for analysis post-hoc.
4. Seabirds and Marine Mammals. Locations, species, numbers and activities observed will be recorded continuously during daylight hours by three Marinelife observers from bridge.
5. Ferrybox Continuous CTD/Thermosalinigraph. Continuously collect oceanographic data on the sea surface during steaming.
6. Marine litter (1): Marine macrolitter in the trawl will be weighed.

1.5 Additional objectives

7. Marine litter (2) Depending on time available and weather conditions, where possible micro plastic samples will be collected at plankton/oceanography station using the manta-trawl towed for a minimum of half an hour at 4-8 knots.
8. Tag elasmobranchs, in support of studies on their movement patterns in western Channel and Celtic Sea
9. Collect rare species for Jim Ellis (Cefas)

1.6 Narrative

RV Cefas Endeavour left Lowestoft port at 9:30 during the morning tide of the 18th of May (after the necessary inductions). After about an hours' steam the Engels 800 pelagic trawl was deployed off Sizewell to give her a soak, fine-tune her geometry and get a feel of the gear. After several hours of experimenting with limited success, Cefas Endeavour set off for deeper waters in the eastern Channel with the aim to continue the gear experiment the next morning. During the morning of the 19th of May from 8:00, the Engels 800 trawl was further tested in the western Channel (50° 21.43N; 01° 16.70 W) until at 10:00 a shake-down tow was successfully made. The rest of the day was reserved to calibrate the echosounders. This involves suspending a small metal sphere (of known target strength) underneath the transducers from three points on the deck and requires very calm conditions. Despite the reasonable weather very strong tides made it impossible to control the sphere and after 14 hours, the calibration exercise was abandoned. The most recent calibration file was loaded, until another opportunity was found to do the calibration again.

Between the 20th of May and the 7th of June the western Channel and Celtic Sea shelf area were covered systematically. Parallel equidistant acoustic transects perpendicular to the coast were run at fixed vessel speed of 10 knots starting in English waters of the western channel, moving into French waters (22-24th May). Bad weather forced the survey to skip the northern Cornish coast, moving into the Bristol Channel first after which long transects were covered between the Irish south coast and northern Cornwall (28-29th May). From the 30th of May the shelf edge was surveyed from the North downwards and by 3rd of June the vessel steamed back from the edge eastwards across plateau to perform a number of high resolution acoustic grids, on Jones' Bank / Haig Frass (4th of June) and around the Cornish coast. Transects designed prior to the survey were used a s aguide but the presence of numerous traffic separation zones, required continuous adjustment to the originals. Weather, swell and strong tides continuously present during the survey prevented a second calibration but the data from the last calibration were of very high quality.

Fixed oceanographic and plankton stations were successfully sampled along the various transects. In order to collects plankton samples two ring nets were used, a 1 meter ring net with a 270 microns mesh for ichthyoplankton samples and a 0.5 meters ring net with a 80 microns mesh for a zooplankton samples. Both nets had flowmeters (General Oceanics mechanical flowmeters with standard rotor, model 2030R) mounted in the centre of the "mouth" and a min CTD (SAIV) was attached to the bridle. A rosette with a CTD which was deployed prior to the ringnet deployment providing *in situ* information on the presence (and depth) or absence of the thermocline. As it was assumed that most fish eggs of pelagic species float above the thermocline layers, the plankton nets were only deployed to the depth of the thermocline or, if absent, down to just above the seabed. Position, date, time, seabed depth, angle of the net, sampled depth (from CTD attached to net) and flowmeter reading were recorded. Samples were transferred from the "bag ends" into 1 lb glass jars and preserved with 4% buffered formaldehyde.

Vertical profiles of the oceanographic conditions in the Celtic Sea were made at regular stations along the acoustic transects, using a Rosette fitted with a Falmouth Scientific Inc. Integrated (FSI) CTD. Temperature, Pressure, Conductivity, Photosynthetically Active Radiation, Turbidity and Fluorescence were measured. Twelve additional temperature profiles have been obtained from a CTD attached to a plankton net. Salinity was calculated from conductivity measurements using 'Algorithms for Computation of Fundamental Properties of Seawater' (UNESCO, 1983). All salinities quoted here after are practical salinities.

Throughout the survey marine mega-vertebrate and sea bird surveys were conducted during daylight hours both whilst on dedicated acoustic transects and off transect. Effort data were recorded every 15-30 minutes or more frequently if weather conditions or the vessels direction/speed changed. Data recorded included ship's location, course, speed, sea state, visibility, cloud cover, swell height, wind- speed/direction and precipitation type/intensity. For all cetacean and sea bird sightings time, species, number, age and behaviour of individuals were recorded. More detailed data were collected for cetacean species and Balearic shearwaters, *Puffinus mauretanicus*, which included angle and distance from vessel when first sighted, encounter duration, weather conditions, associated sea birds and any behavioural changes (e.g. responsive movements towards/away from the vessel).

2. Preliminary Results from the survey

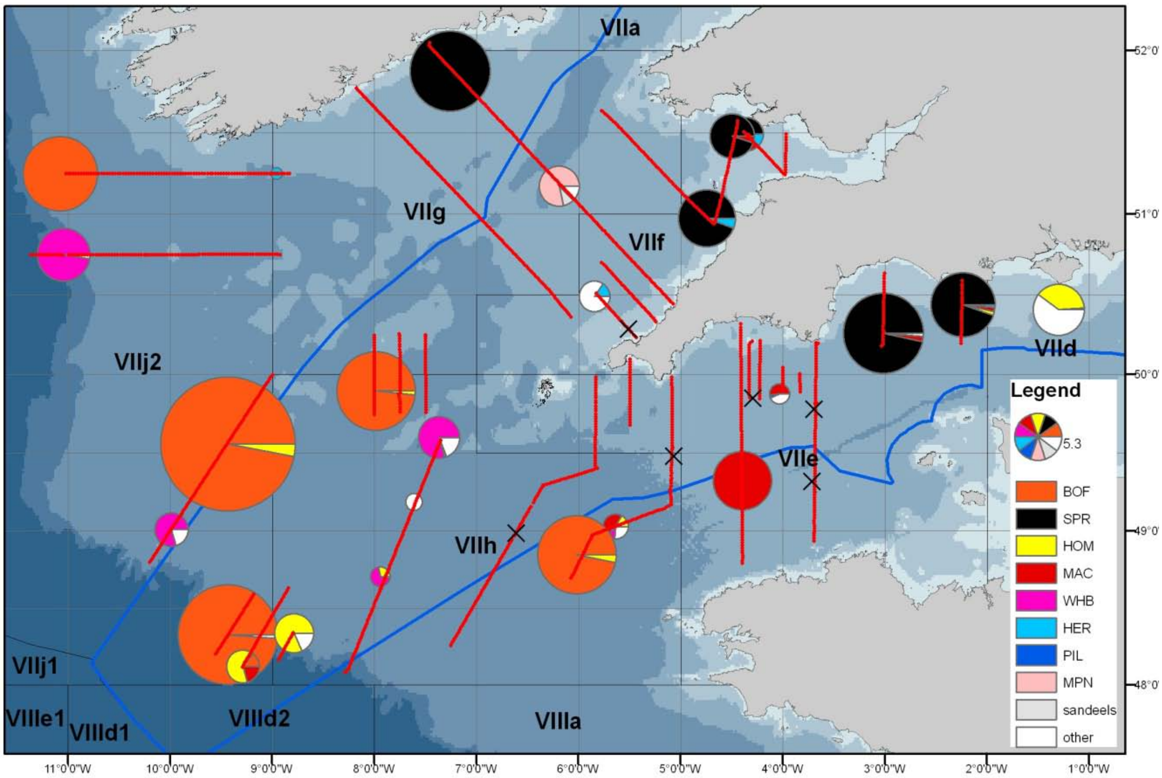
2.1.1. Fisheries Acoustics

Acoustic data were successfully recorded at three operating frequencies (38, 120 and 200kHz) throughout the survey. In general the quality of data was very high despite fairly constant windy conditions and Atlantic swell, although occasional spells of very bad weather adversely affected some of the surface data due to aeration. Loss of data was minimal due to the fact that the transducers were mounted on a drop keel, which was lowered to 2m below the hull throughout the survey to retain the sampling volume of the surface. At all times on-transect live acoustic data were monitored and when unidentified acoustic marks appeared the decision was made to trawl on these marks. Although multi-frequency algorithms have been developed to identify different species the data are still being processed and therefore no biomass estimations or distribution patters are available at this point. However good quality data were collected for most species.

2.1.2. Trawl data

Small alterations were made to the original Engels 800 drawings (Appendix 1): 1) added weight to the wings (from 50 to 125kg each); 2) added chain on the footrope; 3) attached warp to the centre of the door and finally 4) some weights were added to the bottom of the doors (substitutes for shoes) to help them settle better in the water column.

A total of 31 trawl were made, 6 of which were empty or contained a single fish. A total of 39 species were caught.



2.2. Plankton data

In total, 67 ichthyoplankton samples and 46 zooplankton samples were collected. From these, 1 ichthyoplankton and 3 zooplankton tows were invalid due to problems with the flowmeters and with the remote winch control. Onboard a semi-quantitative analysis of the ichthyoplankton samples was performed to assess the presence or absence of target eggs. 57 samples out of 66 samples were analysed. Sardine eggs were present in 12 samples, sometimes in very large numbers and no anchovy eggs were found.

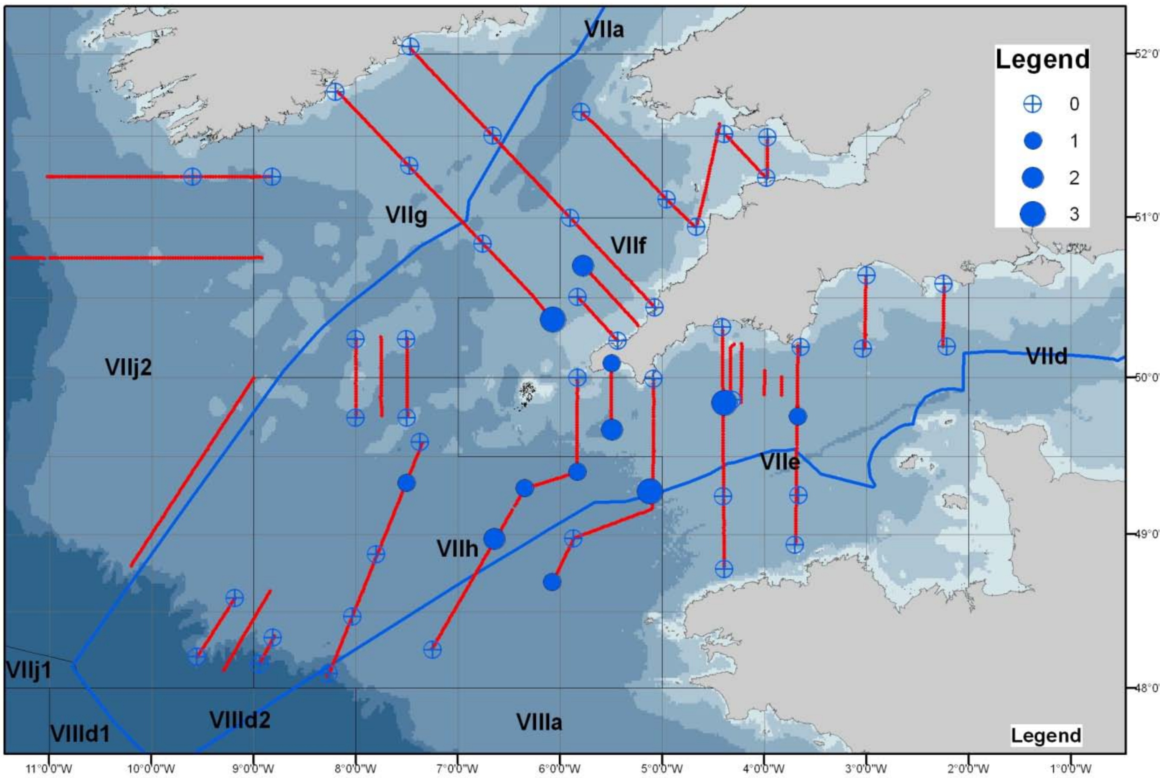


Figure. Ichtyo-plankton stations including those with sardine eggs; 0 = absent, 1=few eggs, 2, reasonable number of eggs and 3=large quantities of sardine eggs.

2.3. Oceanographic data

Vertical profiles of the oceanographic conditions in the Celtic Sea were made at 56 stations by the Cefas Endeavour from 20th May – 7th June 2011 using a Rosette fitted with a Falmouth Scientific Inc. Integrated (FSI) CTD. Temperature, Pressure, Conductivity, Photosynthetically Active Radiation, Turbidity and Fluorescence were measured. Twelve additional temperature profiles have been obtained from a CTD attached to a plankton net. Salinity was calculated from conductivity measurements using 'Algorithms for Computation of Fundamental Properties of Seawater' (UNESCO, 1983). All salinities quoted here after are practical salinities.

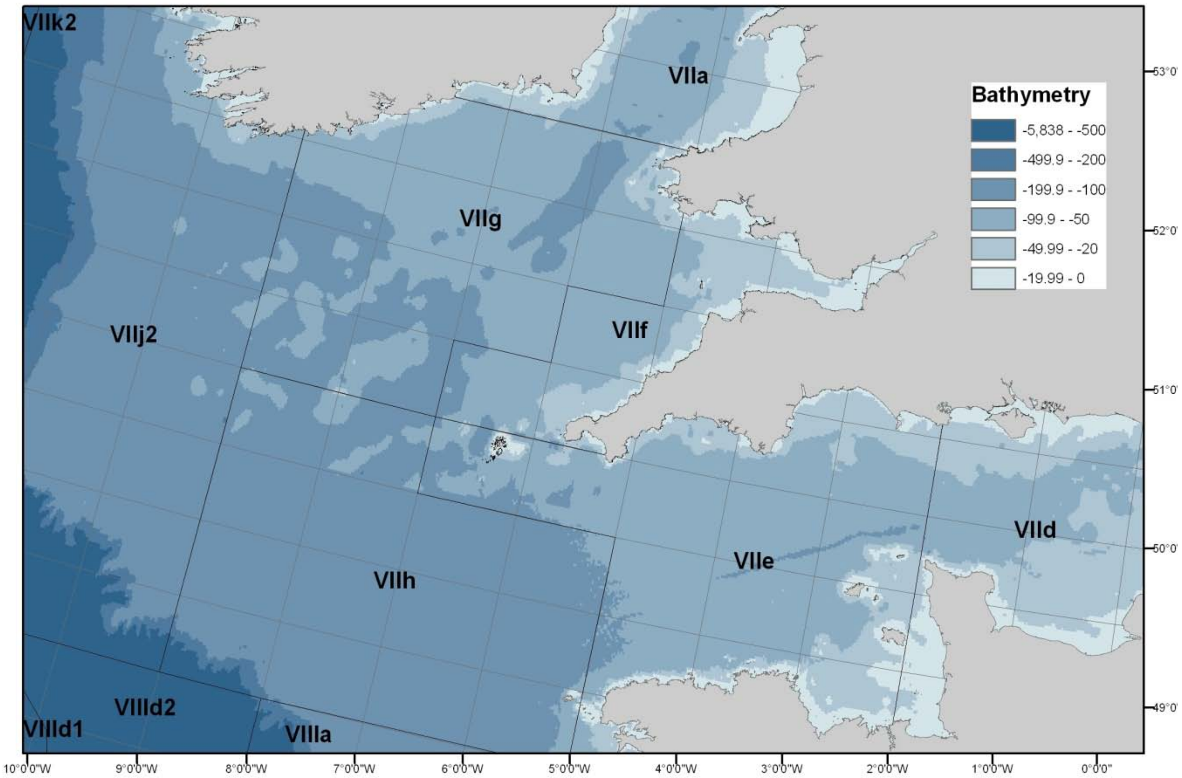


Figure 1: Bathymetry of the Celtic Sea

Calibration of the FSI temperature sensor was performed pre-cruise in the laboratory and values were found to be accurate to ± 0.07°C. The CTD attached to the plankton net was also calibrated pre -cruise and found to be accurate to ± 0.1°C. Temperature values from the Rosette's thermometer were compared against temperature readings from two reversing thermometers which took a reading at the thermocline or deepest point of a profile and against the Ferry box measurement which samples water from an inlet at 5 m depth. The Rosette and reversing thermometers showed a high degree of agreement, on average to 2 decimal places (d.p.). However the Ferry box was on average 0.3 °C higher and the spread of the differences was very small (the standard deviation of the differences was 0.07 (2 d.p.)). Suggesting the Ferry box temperatures are 0.3 °C higher than the actual sea temperature at 5m probably due to the water being heated as it travels through the ship. On average the Ferry box salinity was 0.05 (2 d.p.) higher than the Rosette again with a very small spread around this average (standard deviation 0.03 (2.d.p.)).

Water samples were collected at 50 stations, one sample at the surface and one sample at either the thermocline if it existed or near the sea bed. Four samples were then taken from the water collected at each depth. A salinity sample was taken straight from the niskin bottle. The remaining water was filtered through a 200µm mesh; 4ml of this was mixed with 100µl of glutaraldehyde 8% and stored at -68°C for flow cytometry. A 1000ml of water from each depth was filtered a second time through a GF/F filter. The filter was stored at -68°C for Chlorophyll analysis and 60ml of the twice filtered water was mixed with 100µl of mercuric chloride and stored at 3°C for nutrient analysis.

2.3.1. Stratification

The thermocline depth was recorded to the nearest meter as the depth at which $\frac{dT}{dP}$ was maximised, were T is temperature and P is pressure.

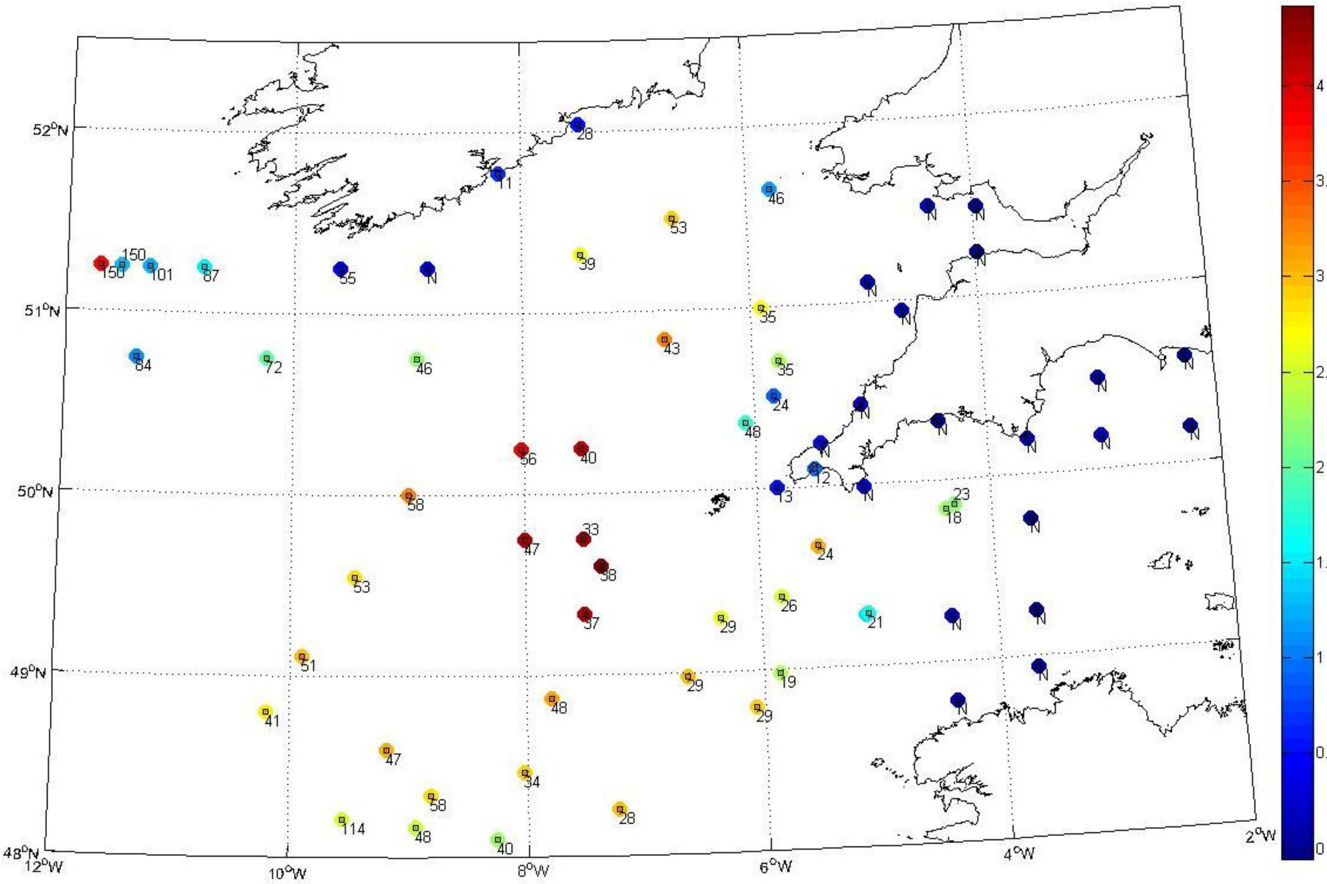


Figure 2: Thermocline Depth and Stratification Strength

Figure 2 shows the thermocline depth at each station (written in black) and the temperature difference (°C) between 2 db and the deepest observation, which is a measure of the strength of the stratification. If the thermocline depth is N it means the water column was well mixed. The figure shows that coastal waters are well mixed (English and Bristol Channels) or weakly stratified (Irish coast) and open waters stratified with the strongest stratification (over 4°C) in the centre of the Celtic Sea. It should be noted that whilst the most westerly station (51.25°N, 11.71°W) also has a 4°C temperature difference the thermocline was not as strong here. The difference can be attributed to the fact the temperature continued to gradually drop below the thermocline and this measurement is over 500m deeper than any other observation. The English and Bristol Channels are well mixed due to the strong tidal forces acting and the shallowness of the sea bed. The figure also shows that thermocline depth increases greatly at the shelf edge.

Atlantic low-pressure systems tracked eastwards bringing unseasonably windy weather between 21st and 24th May which will have increased ocean mixing. It is therefore likely that these thermocline depths are deeper than usual for this time of year. Measurements taken before the 21st May were all in the well mixed English Channel.

2.3.2. Temperature Distribution

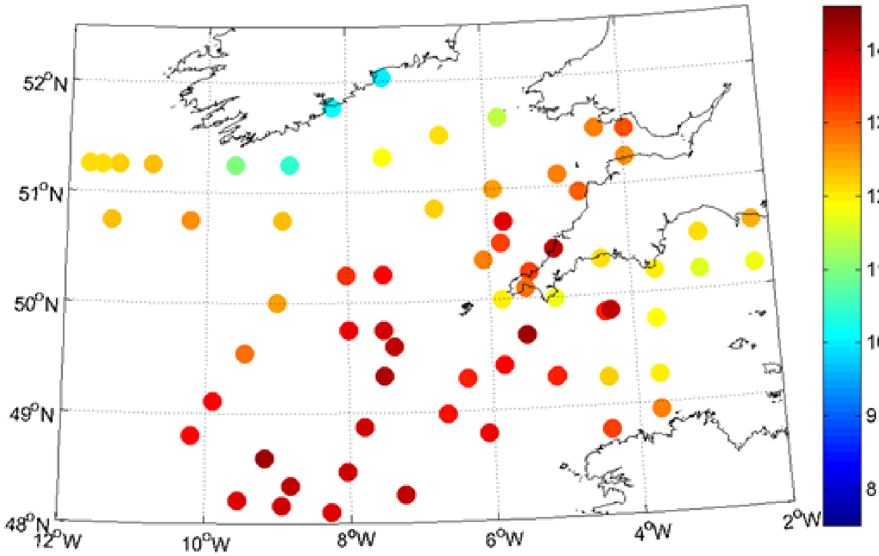


Figure 3: Temperature (°C) at 2 db

Figure 3 shows the temperature distribution just below the surface (2 db). The gulf stream of warmer water travelling from the south west driven by differences in water density and the prevailing surface winds is clearly visible. Another distinct feature is the cold mass of water off the Irish south coast which persists for about 30m. This current of cold water above the thermocline is coming from the Irish Sea as described in Brown et al. The tongue of warm Atlantic water retreats back to the shelf edge as depth increases, disappearing at around 40 db.

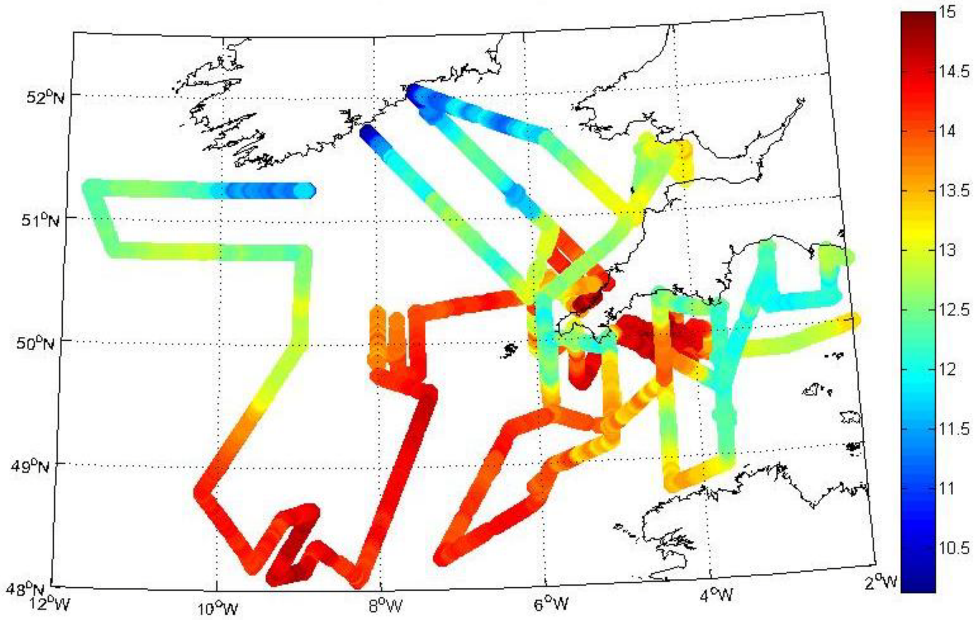


Figure 4: Ferry box Temperature (°C)

Figure 4 shows the Ferry box temperature, which is the temperature 5 m below the surface. The pattern shown is very similar to that seen in figure 3. The extra coverage supplied by the Ferry box shows that the colder stream of water off the south coast of Ireland extends right to the south west tip of the country but is very narrow and does not extend far into the Celtic Sea.

A comparison of the observed temperature at 5 db to the May/June mean climatology (1971-2000) near the sea surface[3] shows that the Gulf Stream is slightly warmer than average (0.5 - 1°C) and the cold flow south of Ireland is colder than average, especially further west (about 2.5°C) which may suggest it is extending further west than usual.

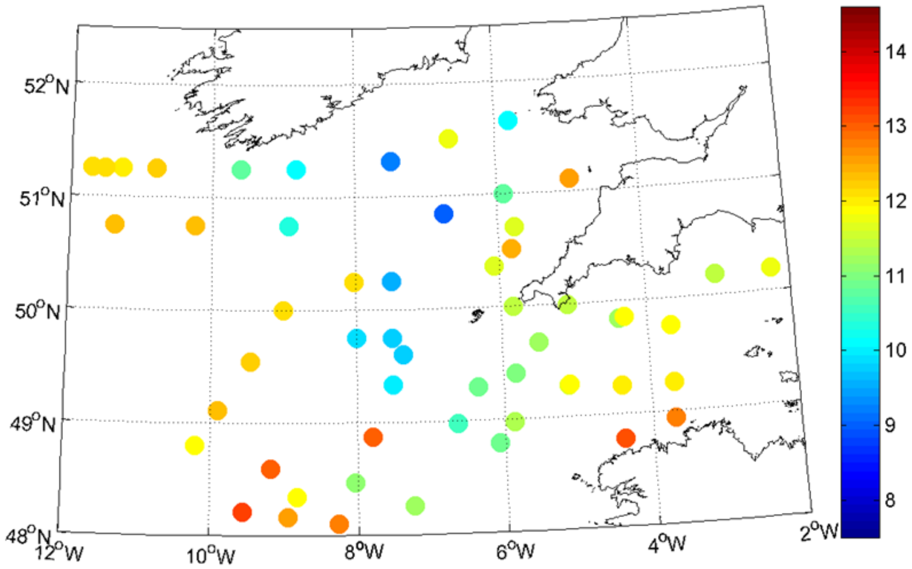


Figure 5: Temperature (°C) at 48 db

Figure 5 shows the temperature at 48 db: a depth which is generally below the shelf thermocline but above the thermocline of the deeper Atlantic water. Here the warmer upper layer of Atlantic water is visible around the shelf edge. There also appears to be a cooler pool of water in the centre of the Celtic Sea. This pattern remains fairly constant as water depth increases to the sea bed with the warmer Atlantic mixed waters retreating further south west.

Temperatures near the sea bed were also compared to the mean May/June climatology (1971-2000). It was found that temperatures are warmer than average in the Bristol Channel and colder than average in the central Celtic Sea. Air temperatures in May around the Bristol Channel were also above average (0.8°C higher than the 1971-2000 climatology[1]) which will have heated this shallow well mixed channel.

2.3.3. Salinity Distribution

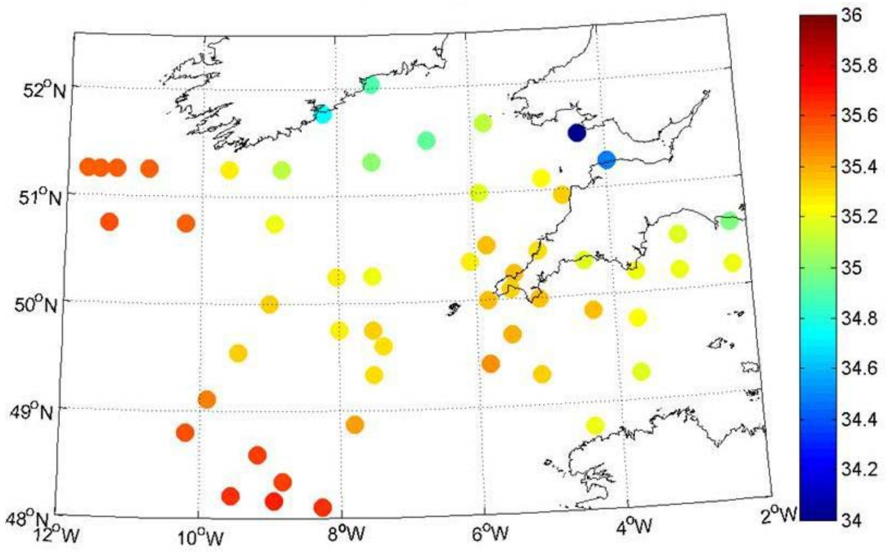


Figure 6: Salinity at 3 db

Figure 8 shows the salinity distribution at 3 db: the more saline Atlantic water is well defined at the shelf edge and the Bristol channel is considerably fresher. Brown et al. proposed that the Celtic Sea circulation advects water from the Bristol channel towards the Irish Sea and then back into the central Celtic Sea or along the Irish south coast; this pattern of salinity supports their findings. The salinity distribution changes very little as you move down the water column; the only change is a small increase in salinity below the thermocline at stations in the north Celtic Sea.

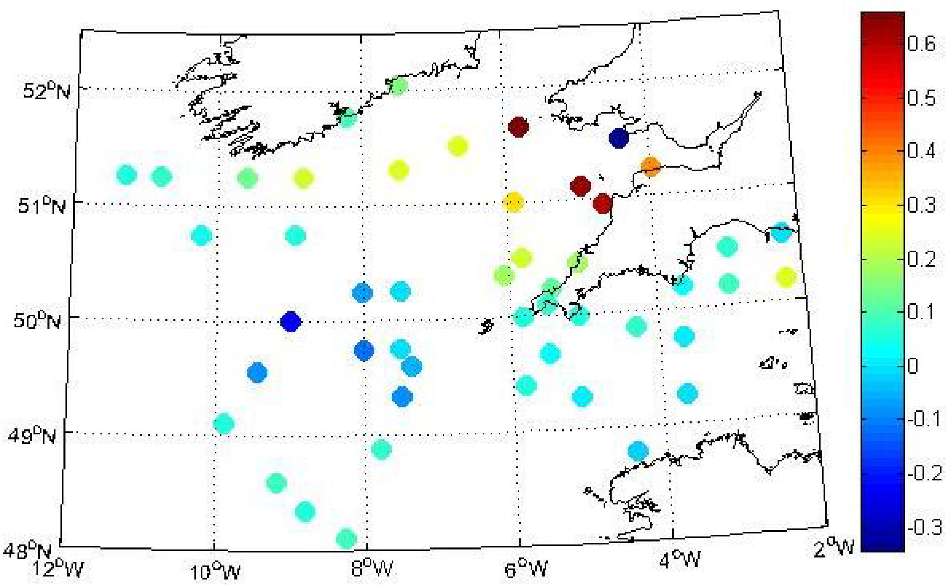


Figure 7: Salinity difference between observations and May/June mean climatology (1971 – 2000) near sea bed

Near sea bed salinity measurements are around average for this time of year with the exception of the Bristol Channel , which is more saline than average. Sea surface measurements display the same pattern but the above average region of salinity extends out of the Bristol Channel and into the north Celtic Sea. It is not surprising that the Bristol Channel is more saline than average as river flows in south west England and south east Wales were also below average in May[2] due to the dry weather southern Britain had been experiencing in the weeks preceding the cruise (78% of the average rainfall fell in south west England and southern Wales in May[1]). Unseasonably strong winds in the days before the Bristol Channel samples were collected (26th May) will have increased the salinity further by increasing evaporation. One station in the Bristol Channel does not fit in with this overall trend. The observations at this station were made at 8pm on the 26th May: a day with heavy thundery showers, it is also very close to the mouths of the River's Loughor and Tawe and so it is likely that the day's weather will have reduced salinity at this station.

References

[1] http://www.metoffice.gov.uk/climate/uk/2011/may/averages.html [accessed 21/06/2011 10:24]

[2] http://www.environment-agency.gov.uk/static/documents/Business /Drought_management_briefing_26_May_2011.pdf [accessed 17/06/2011 15:33]

[3] Berx, B. and Hughes, S.L., 2009. Climatology of surface and near-bed temperature and salinity on the north-west European continental shelf for 1971-2000. Continental Shelf Research 29, 2286-2292.

http://www.metoffice.gov.uk/climate/uk/2011/may.html [accessed 21/06/2011 10:20]

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Brown, J., Carrillo, L., Fernand, L., Horsburgh, K.J., Hill, A.E., Young, E.F. and Medler, K.J., 2003. Observations of the physical structure and seasonal jet-like circulation of the Celtic Sea and St. George's Channel of the Irish Sea. Continental Shelf Research 23, 533-561.

UNESCO, 1983. Algorithms for computation of fundamental properties of seawater. UNESCO Technical papers in marine science 44, 6-9.

2.4. Marine Mammals and birds

Despite adverse weather and resultant poor sighting conditions for a lot of the trip, a total of 5 cetacean species were encountered; two species of dolphin (common dolphin, *Delphinus delphis*, and bottlenose dolphin, *Tursiops truncatus*) and three species of baleen whale (minke whale, Bal*aenoptera acutorostrata*, fin whale, *Balaenoptera physalus* and humpback whale, *Megaptera novaeangliae*). Dolphins were seen in coastal waters around Cornwall and Wales with large groups (100+) seen during transects running across the Celtic sea between southern Ireland and the western UK. Several juvenile bottlenose and common dolphins were also seen. Two minke whales were seen off south Wales and north Cornwall. A group of 21+ fin whales were also encountered over a 10 mile stretch of UK waters (c. 70 miles off the coast of south west Pembrokeshire) crossing the Celtic deep. A lot of krill and sand eels were found in this area and whilst most of these individuals passed us in groups of c.2-7 at distances of >1000m they were blowing frequently consistent with foraging behaviour and indeed the closest individual (c.500m) was observed feeding below the surface. One humpback whale was also seen, albeit very briefly, head breaching and flipper slapping c.50 miles south of Ireland. Surprisingly, no cetaceans were sighted over shelf edge/offshore transects. One shark species (probable blue) was also seen off the south coast of Cornwall.

Several groups of sea birds were encountered including gannets (Sulidae), gulls/terns (Laridae), shearwaters (Procellariidae), auks (Alcidae), petrels (Hydobatidae), skuas (Stercorariidae) and cormorants (Phalacrocoracidae). Also encountered were swallows (Hirundinidae), ringed pigeons/collard doves (Columbidae) and a few unidentified passerine species. Species of particular interest included two Balearic shearwaters (near Lundy island and Lands end), one great shearwater (*Puffinus gravis*, near Ille D'Ouessant), two cory's shearwater (*Calonectris diomedea*, near Lyme Bay/Lizard point), three sooty shearwaters (*Puffinus griseus*, near Ille D'Ouessant and in the western approaches), one adult sabines gull (*Larus sabini*, in the western approaches), a number of puffins (*Fratercula arctica*, including juveniles) and European storm petrels (*Hydrobates pelagicus*, predominantly whilst trawling). Four adult pomarine skuas (*Stercorarius pomarinus*) including one definite adult dark morph were also encountered in the western approaches. One other dark pomarine skua was seen with a shorter tail; it was thus not clear if this was a juvenile or another dark morph individual.